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Information Relevant to the Identification of Critical Habitat for Cumberland Sound Belugas (*Delphinapterus leucas*)

Renseignements pertinents en vue de la désignation des habitats essentiels pour les bélugas de la baie Cumberland (*Delphinapterus leucas*)

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ABSTRACT

In spring of 2004, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designated belugas in Cumberland Sound as Threatened. In anticipation of possible listing under the *Species at Risk Act* (SARA), a recovery strategy is being written. The strategy must identify critical habitat to the extent possible based on the best information available or a schedule of studies that, when completed, would allow critical habitat to be identified. This report documents the information available on habitat use derived from aerial surveys, tracking data, local knowledge and published literature. It offers an understanding of the seasonal distribution of Cumberland Sound belugas, and the little that is known of the physiographic environment, the prey and predators in the areas they frequent. The research necessary to more clearly establish the biological functions of habitats used by this population of belugas are also described.

RÉSUMÉ

Au printemps 2004, le Comité sur la situation des espèces en péril au Canada (COSEPAC) a désigné les bélugas de la baie Cumberland comme une espèce menacée. Une stratégie de rétablissement est actuellement à l'étude en prévision de l'ajout du béluga à la liste des espèces visées par la *Loi sur les espèces en péril* (LEP). Cette stratégie vise à mettre en évidence autant d'habitats essentiels que possible en se fondant sur les meilleures données disponibles ou sur une série d'études qui, une fois achevées, permettraient le repérage des habitats essentiels. Ce rapport consigne les données existantes sur l'utilisation des habitats, lesquelles données sont issues de relevés aériens, de données de poursuite, du savoir local et de publications scientifiques. Il fait le point sur la distribution saisonnière des bélugas de la baie Cumberland, ainsi que sur nos connaissances limitées de la géographie physique de leur environnement, de leurs proies et de leurs prédateurs dans les zones qu'ils fréquentent. Le rapport décrit également les recherches nécessaires en vue de définir avec plus de précision les fonctions biologiques des habitats auxquels s'attachent ces populations de bélugas.

INTRODUCTION

In spring of 2004, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assessed belugas (*Delphinapterus leucas*) in Cumberland Sound as Threatened. If listed under the *Species at Risk Act* (SARA), a recovery strategy will have to be developed. The Act further requires that critical habitat be identified in the strategy to the extent possible based on the best information available or that a schedule of studies be included that, when completed, would allow critical habitat to be identified. In anticipation of possible listing, a Cumberland Sound Recovery Team was formed in fall 2002 and is now developing a draft recovery strategy. The Team, requested science advice on habitat use that may be considered critical to recovery: (1) what geographic location(s) and/or suite of environmental features in Cumberland Sound could be considered critical for the survival or recovery of beluga whales, (2) what is the geographical availability of habitats that contain those features in Cumberland Sound, and (3) if available information is inadequate to currently allow for the identification of beluga critical habitat, what studies are needed and when would they be completed?

This paper provides information derived from the aerial surveys, tracking data, local knowledge, and published literature. The information presented sheds some light on the Recovery Team's questions. It offers an understanding of the seasonal distribution of Cumberland Sound belugas and the little that is known of the physiographic environment, the prey and the predators in the areas that they frequent.

METHODS

Aerial surveys

Aerial surveys were conducted in summer to estimate the number of belugas in the population (Baratin 2001). The surveys were planned and executed with Pangnirtung beluga hunters, based on their knowledge of Cumberland Sound beluga distribution in early August. They covered all the northern sector of Cumberland Sound, including Clearwater Fiord, as well as the western sector of Cumberland Sound, south to Cape Edwards (Fig.1). These surveys were conducted in the month of August 1999 and included photographic counts of the aggregation in Clearwater Fiord, systematic visual transect surveys of the remainder of the northern sector, and similar surveys of the western sector of Cumberland Sound In addition, visual reconnaissance surveys were flown inside narrow bays and fiords of the western sector of the Sound.

Aerial visual surveys were also conducted in March of 2000 and 2003. They were systematic zigzag surveys over the pack ice and open water portions of the Sound.

Tracking

In addition to the aerial surveys, a total of 14 belugas were instrumented in 1998-1999 and 2006-2007. They were tracked for periods of one to seven months. Estimated locations were obtained from the tracking data using a Bayesian switching state-space model (Jonsen *et al.* 2005, 2007; Luque 2008) which estimates locations at regular intervals from the irregular data of all ARGOS location classes, except Z. During all months in 1998-1999 and from July to September in 2005-2006, the beluga tags were not duty-cycled consequently locations were obtained several times each day. Sub-setting the data from those periods yielded a 95th quantile of distribution of transmission intervals of 10.3 hours. Therefore, we chose to estimate locations at intervals of 12 hours for that data. For the duty-cycled data obtained in the months of October to February 2006-

2007 (3 tags), the 95th quantile of the distribution of transmission intervals was 7.3 days. Consequently, we used an interval of 8 days to estimate locations.

Fixed kernel probability polygons (50 percentile, 75 pc and 95 pc) (Worton 1989, 1995; Hooge and Eichenlaub 1997; Hooge *et al.* 1999) were calculated from the 12-hour locations for the months of July to January. Fixed kernel probability polygons were also estimated from the locations of the duty-cycled data in February, although the number of estimated locations there was very small (n=3). Table 1 shows the sample size used for monthly home range kernel estimates.

RESULTS AND DISCUSSION

Seasonal distribution of Cumberland Sound belugas

Aerial surveys

The summer survey results show that Cumberland Sound belugas are highly aggregated in Clearwater Fiord in August (> 500 animals), and their distribution is more sparse in other parts of the Sound, with a gradient diminishing from north to south (Fig. 2-5). During the March surveys, beluga sightings were seen on both sides of the Sound but were more numerous along the east side (Cumberland Peninsula) (Fig. 6-7).

Tracking

Results show that, in late July, tagged whales ranged from Nettilling Fiord to Clearwater Fiord, where most locations were estimated (Fig. 8) (see Fig. 1 for place names). Their distribution was almost entirely limited to Clearwater Fiord in August (Fig. 9). In September, estimated locations were most numerous in Clearwater Fiord and near the mouth of Kangilo Fiord but many ranged far south down the western side of Cumberland Sound (Fig. 10). In early autumn (Oct.), locations were estimated further south (Fig. 11) and further east in late autumn (Nov.-Dec.) (Fig. 12-13) to the southeast side of the Sound, along Cumberland Peninsula, near its mouth. The two animals that transmitted in January (tag # 20162_001_A1999) and February (Tag # 57594_001_W2006) were still in that area (Fig. 14-15). The wintering range of Cumberland Sound belugas probably centers in that area since several sightings of belugas were made there during March surveys (see above).

Local knowledge of distribution

An Inuit knowledge study on Southeast Baffin Belugas (Kilabuk 1998) reports similar information on the summer and autumn range of belugas in the Sound (Fig, 16c-d). It does not report winter sightings as belugas are probably in areas that hunters cannot reach at that time of the year. On the other hand, it does provide information on spring distribution, which is so far not available by any other means. The report indicates that some belugas are seen near the floe edge in early spring (Fig. 16a). As ice breaks up in spring, they move into Kangilo Fiord, and these migrants are reported to originate from the west side of the Sound (Fig. 16b).

Physiographic features that characterize beluga habitat use

Cumberland Sound is a large bay, with maximum depths ranging in excess of 1000 m (Fig. 17). The deepest parts (500-1000+ m) are in a trench in the mid-eastern portion of the Sound,

separated from Davis Strait by a sill near its mouth (Fig. 17). Fiords on the northeast and east side are also deep (100+ m). Clearwater Fiord, where belugas spend a good portion of the summer, ranges down to 190 m (Fig. 18) (Smith 2003). In its mid-northern portion, the depths rise steeply to form a shallow bay called Millut Bay or "Midlurialik" (Fig. 18), where the cold, fresh and heavily-silted waters of the glacial Ranger River empty, forming a shallow estuary, which is almost dry at low tide. One suggestion for the attraction of belugas to estuaries is that their warm fresh water promotes moulting of the skin in summer (St. Aubin *et al.* 1990) or that calves born in estuaries benefit from the warmth at a period where they are more vulnerable to heat loss (Sergeant and Brodie 1969, but see Doidge1990 for an opposing view). But unlike sub-Arctic rivers used by belugas, the Ranger River discharges glacial waters into Mullit Bay which, according to local people, is colder than the sea water. Yet, belugas aggregate there in large numbers for several weeks every summer and it is the only known calving place in Cumberland Sound (Kilabuk 1998).

The west side of the Sound and, to some extent, the northern sector have a wider shelf and a gentle slope ranging down to about 400 m. Starting at Kangilo Fiord (Fig. 1, B), bays and fiords on the west side are also relatively shallow (bathymetric data unavailable). Small numbers of belugas are found along that shelf and in the bays along the west coast. Small groups of belugas have been known to become trapped in bays on the west side that have shallow sills at their entrance, such as Irvine Inlet in the southwest portion of Nettilling Fiord (Fig. 1). In those circumstances, belugas can remain trapped until a large tide affords them a chance to exit or they may not be able to exit at all and are either captured by local hunters or die in the shallow bay as the ice forms around them in early winter.

During the year, belugas occupy areas with variable depths but a comparison of depths at locations with random depths across the Sound suggests that they have a preference for certain depths and that their preference varies seasonally. We only had enough data in the months of September to November (Fig. 18-20) for such a comparison. Depths corresponding to mean daily locations (location classes 1-3) were significantly different from depths obtained from randomly distributed points (χ^2, $p < 0.0001$). This comparison suggests selection by belugas for certain water depths (White and Garrott 1990) during those months. In September, tagged belugas preferred to use waters between 0 and 300 m (Fig. 10) but, in October, they used the shallow water areas less frequently and showed a net preference for depths between 200 and 500 m (Fig. 11). In November, this preference for deeper water continued as they occupied waters between 200 and 500 m (Fig. 12). There was also a small peak at 700-800 m.

Biological features that characterize beluga habitat use

Marine fish species that are abundant in the eco-region that includes Cumberland Sound, and that occupy that range of depths frequented by belugas, are many (Jim Reist, Fisheries and Oceans Canada, Winnipeg, pers. comm.). The most plentiful are Arctic cod (*Boreogadus saida*) and Greenland halibut, aka turbot (*Reinhardtius hippoglossoides*) but capelin (*Mallotus villosus*), Greenland cod (*Gadus ogac*), gelatinous snailfish (*Liparis fabricii*), Arctic alligatorfish (*Ulcina olrikii*) and several species of sculpins (*Gymnocanthus* spp. and *Myoxocephalus* spp.) are also abundant. Some or all of those species may be targeted by feeding belugas in Cumberland Sound, although the alligatorfish and sculpins are not very fleshy or fat and have spines and sharp opercula so they are probably poor-quality prey. Belugas are known to eat shrimp, squid, and benthic crustaceans (Brodie 1970; Heide-Jørgensen and Teilmann 1994) and may also target those prey species in Cumberland Sound in autumn when in deep water. Brodie (1967, 1970) reported that the stomachs of belugas taken in Clearwater Fiord in summer were often empty but those that had contents had a variety of benthic organisms. The most abundant contents were

remains of small cod species (*Gadus ogac* and *B. saida*), squid beaks (*Gonatus fabricii*) and an amphipod (*Anonyx nugax*). The squid were identified only by their beaks and could have been taken earlier in winter or spring because the hard squid beaks remain in the stomachs long after the flesh has been digested (Finley and Gibb 1982).

Local people report that belugas eat Arctic cod and Greenland halibut at the floe edge in spring (Kilabuk 1998). That floe edge runs over 200-400 m of water. When belugas return to the Sound in the autumn, they also feed near the mouth of Kangilo Fiord (Kilabuk 1998).

Other than hunting by man, predation by killer whales (*Orcinus orca*), and entrapment by ice are important causes of beluga mortality (Mitchell and Reeves 1981; Reeves and Mitchell 1988; Kilabuk 1998). Killer whales have long been regular summer visitors to Cumberland Sound; generally appearing after the pack ice disperses in search of prey (MacLaren Atlantic Ltd. 1978; MacLaren Marex Inc. 1980; Reeves and Mitchell 1988). Historically, killer whales were commonly seen around Blacklead Island and the Kikastan Islands (Fig. 1, F-G) (Reeves and Mitchell 1988). In the 1960's, hunters expressed concern that their numbers were increasing and that they were reducing the numbers of harvested marine mammal species. In the mid-1970's, they frequented the mouths of Kingnait and Pangnirtung fiords (Fig. 1, D-E) in August and September (Stewart and Savard 2003). In October 1977, local Inuit killed fourteen killer whales in a bay of Kekertellung Island (Fig. 1, C). Since that event Pangnirtung elders have observed that belugas, which normally remained in Clearwater Fiord until October, are leaving the fiord earlier, in late August (Kilabuk 1998). This observation suggests that Clearwater Fiord may act as a refuge from killer whales in summer. The most direct entrance to the Fiord is a shallow strait with strong riptide currents that may act as a deterrent to killer whales. Other access points are farther south and require navigation through island passages.

Two local elders reported that many years ago hunters saw evidence of killer whale attacks on belugas, including pieces of beluga *maktaq* and viscera floating in the water (Holly Cleator, DFO, pers. comm.). In 2002, a pod of 10 killer whales was seen coming from Clearwater Fiord and hunters reported seeing evidence of renewed killer whale predation on both belugas and bowheads (Stewart and Savard 2003). Killer whales were also seen in the Sound in August 2008 (Steve Ferguson, DFO, pers. comm.). Polar bears (*Ursus maritimus*) also prey on belugas to a limited extent (Freeman 1973; Smith 1985; Smith and Sjare 1990) but it is not clear how important that source of predation is to Cumberland Sound belugas.

Sea ice features that characterize beluga habitat use

The coastal shelf around Cumberland Sound is covered with fast ice throughout winter. Heavy pack ice covers the remainder of the Sound except for a few areas of recurring open water. One of these areas is a large polynia near the southeast coast, along Cumberland Peninsula, apparently caused by a combination of winds and currents (Fig. 22). This is where the belugas were last tracked in January and February (Figs 14-15). Beluga sightings during aerial surveys in March 2003 were also found in this area though in mid-winter, when ice cover is quite extensive, some animals are also further west in the pack ice (Figs. 6-7).

A lead also forms along the northern margin of the fast ice when northwest winds displace the pack ice (Fig. 22). At times this lead can be quite large, several tens of kilometres, but it can also narrow or close with strong south winds. This lead is apparently occupied by belugas in early spring (Kilabuk 1998). A number of minor polynias are kept open by tidal currents at the mouths of several bays and fiords around the Sound. The Hunters and Trappers Organisation have occasionally reported belugas that were trapped in such tidal polynias.

Large ice entrapment events are not frequent but are known to occur in Cumberland Sound. Elder informants speak of an ice entrapment of 100 belugas in 1956 on the west side of the Sound. They speak of another entrapment of more than 35 belugas in Irvine Inlet (no date given). For the most part, other entrapments have been reported to affect only a few individuals at a time (Kilabuk 1998). Ice entrapments can be a major source of mortality if weather conditions remain stable and cold and the ice does not break open for months to release the entrapped whales (Heide-Jørgensen *et al.* 2002). Consequently, it would be a good strategy for belugas to seek areas with reduced ice-entrapment potential such as the southeast polynia, along Cumberland Peninsula, especially in the months when winter ice is forming rapidly.

Fast ice starts to break up in June and, in the past, belugas would follow leads into the ice at that time. Elders say that this behaviour is no longer observed and blame snowmobiles and motorized boats for keeping belugas away (Kilabuk 1998). When the fast ice is completely broken up in late July, belugas make their way to Clearwater Fiord (Kilabuk 1998).

CONCLUSIONS

This paper provides useful information on the seasonal distribution of Cumberland Sound belugas and what is known of the physiographic environment, the prey and the predators in the areas that they use.

1) *What geographic location(s)/area(s) and/or suite of environmental features in Cumberland Sound could be considered critical for the survival or recovery of beluga whales?*
2) *What is the geographical availability of habitats that contain those features in Cumberland Sound?*

Results suggest that Cumberland Sound belugas are relatively sedentary, inhabiting Cumberland Sound year-round. They summer mainly in Clearwater Fiord, but also range over adjacent areas of the northern sector, presumably seeking protection from killer whales in that complex coastline. In autumn, they range mostly over the shelf on the west of side of the Sound, where they prefer waters with depths between 200 and 500 m but occasionally make deeper incursions, presumably to take advantage of prey species that inhabit those depths. Later in the season, they move further south to the mouth of the Sound for the winter, and in particular to the southeast sector, which has a recurring polynia. The southeast polynya, along Cumberland Peninsula, may serve to avoid entrapment, a potentially important source of mortality, as the ice forms over almost the entire Sound but remains lighter in that area. In mid-winter, when ice cover is quite extensive, many are still found in the southeast polynia but some animals are also further west in the pack ice. In spring, belugas return to the northern sector where they feed along the floe edge on arctic cod and Greenland halibut. They move into Clearwater Fiord once the ice allows them access.

3) *If available information is inadequate to currently allow for the identification of beluga critical habitat, what studies are needed and when would they be completed?*

To more clearly establish the biological functions of habitats used seasonally by belugas in Cumberland Sound would require considerable research investment in several areas:

a) Feeding ecology, including stable isotope and fatty acid analysis of the belugas and their prey, with stomach analysis at different times of the year.
b) Satellite-linked telemetry using stomach pills to understand the seasonality of feeding.

c) Extensive ichthyologic and macro-invertebrate studies of the Sound to determine the seasonal availability of prey to belugas.
d) Documentation of killer whale attacks.
e) Documentation of ice and tidal entrapment events.

Such studies would probably require a decade or so to complete. Some of these studies (a and b) may not be politically acceptable, because they require handling of animals, or logistically feasible if they require hunting at a time of year when there is no local hunt.

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Table 1. Location samples used for home range kernel estimation.

Month	No. belugas	Average sample count	Min sample count	Max sample count	CV
July	1	32	32	-	-
August	8	23	2	57	42%
September	13	50	6	59	8%
October	9	56	46	62	8%
November	7	39	4	62	22%
December	3	31	12	62	51%
January	1	28	28	-	-
February	1	3	3	-	-

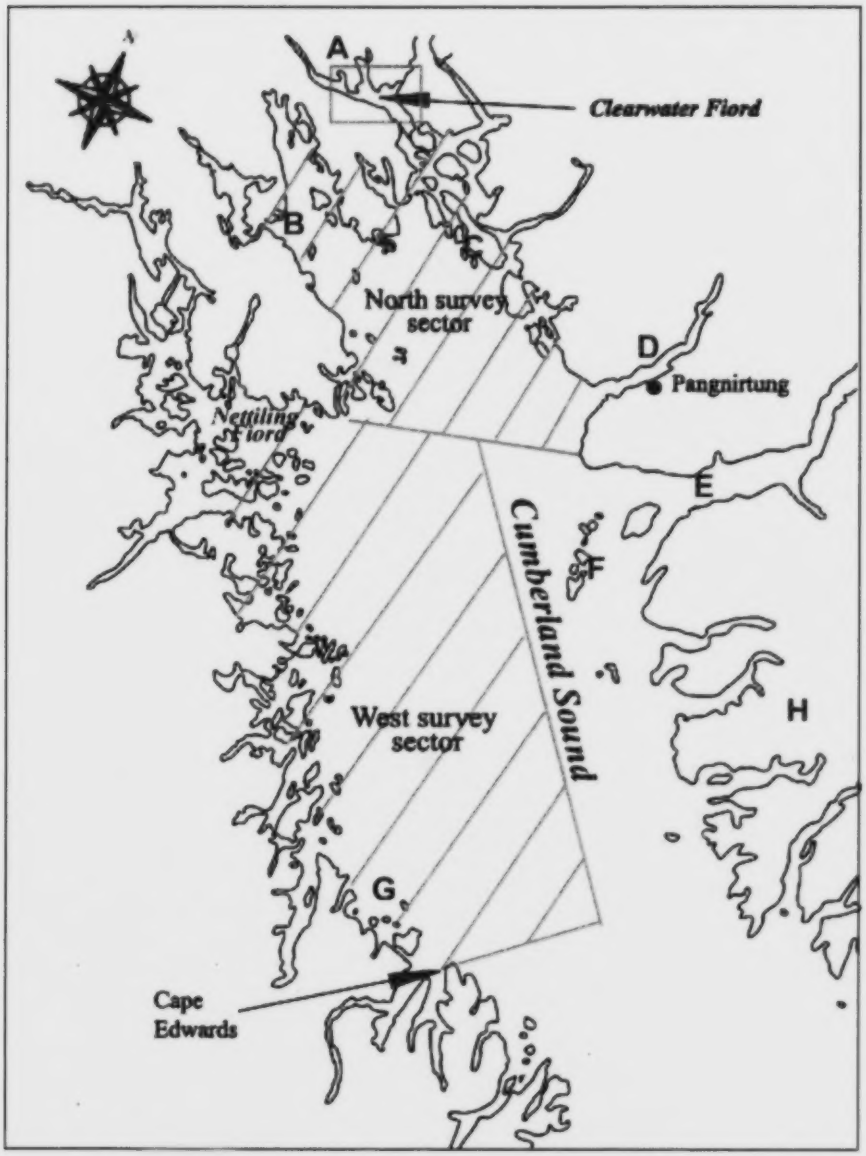

Figure 1. August 1999 aerial survey study area and delimitation of survey sectors. Place names referred to in the text: Millut Bay (A), Kangilo Fiord (B), Kekertelung Island (C), Pangnirtung Fiord (D), Kingnait Fiord (E), Kikastan Islands (F), Blacklead Island (G) and Cumberland Peninsula (H).

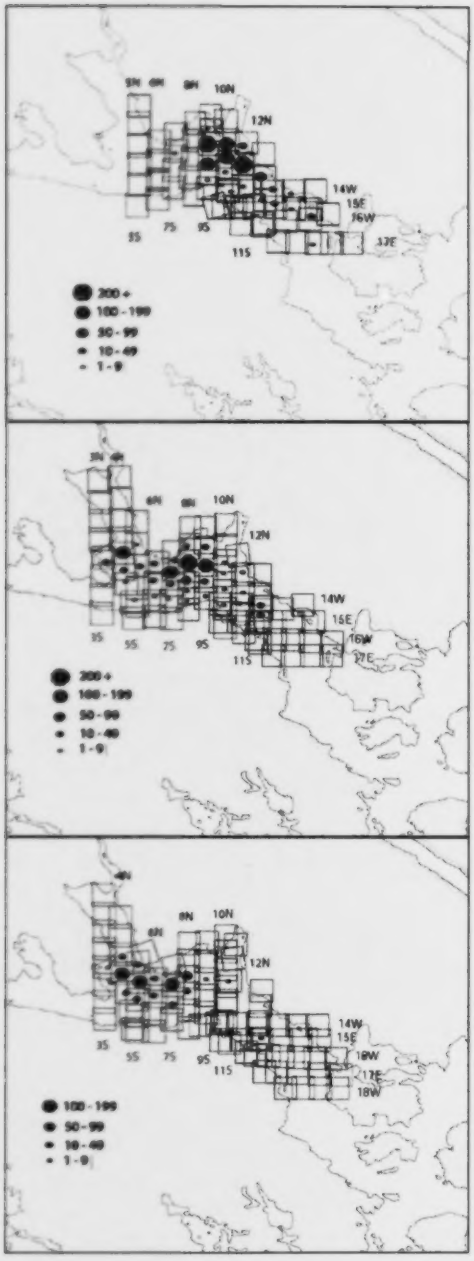

Fig.2. Aerial photographic survey counts of Clearwater Fiord beluga aggregation in August 1999 (top to bottom: 6, 7 and 8 August)

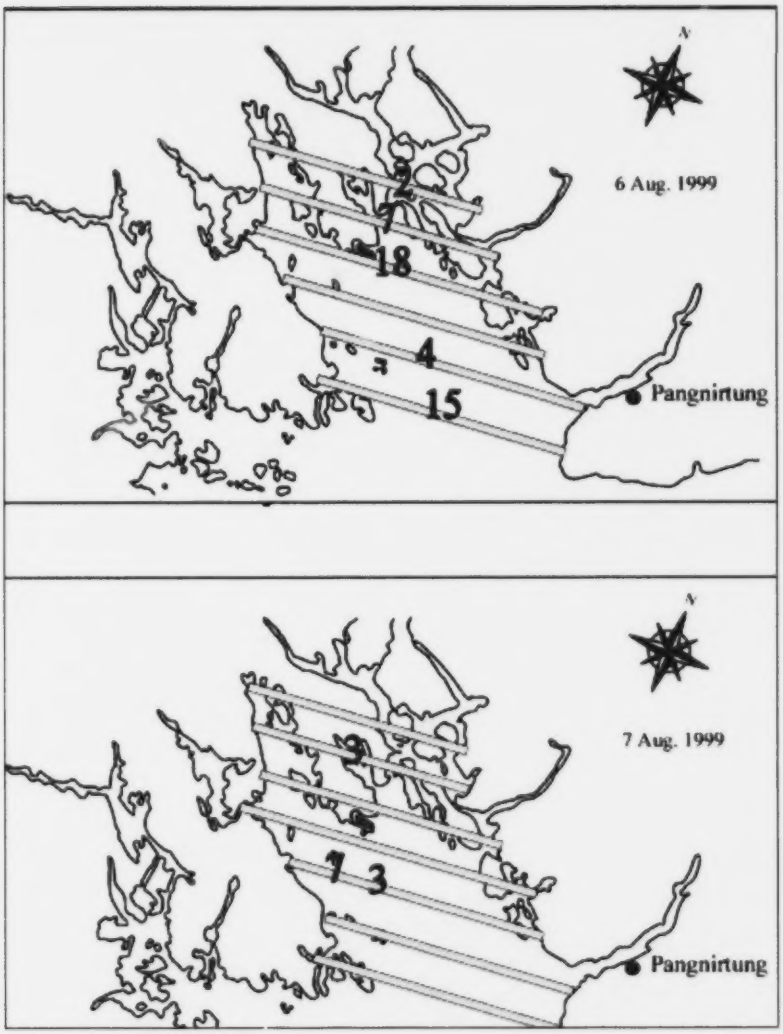

Figure 3. Aerial visual systematic strip transect surveys of the northern sector of Cumberland Sound in August 1999.

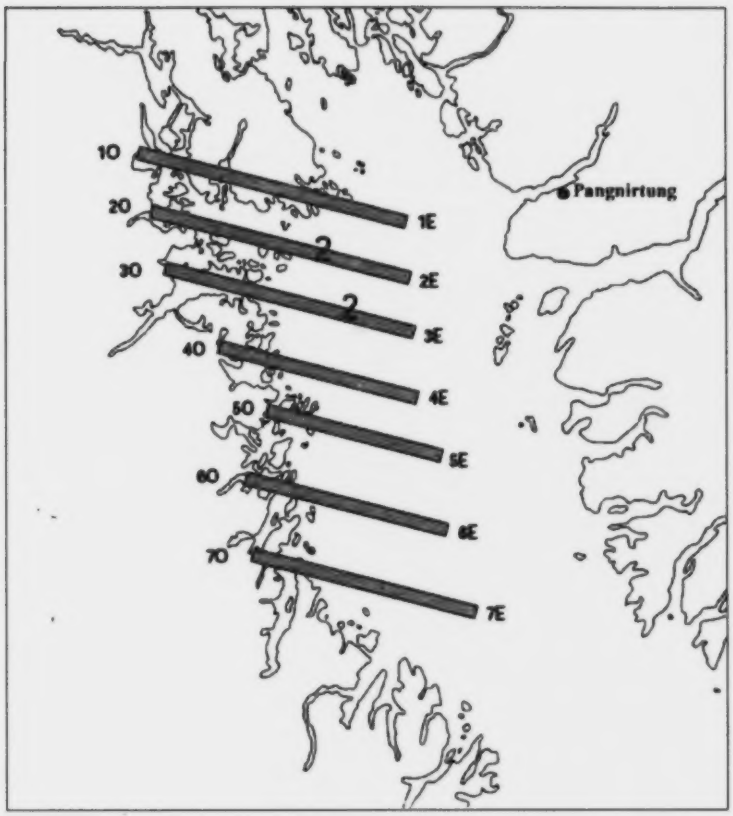

Figure 4. Aerial visual systematic strip transect surveys of the western sector of Cumberland Sound on 6 August 1999.

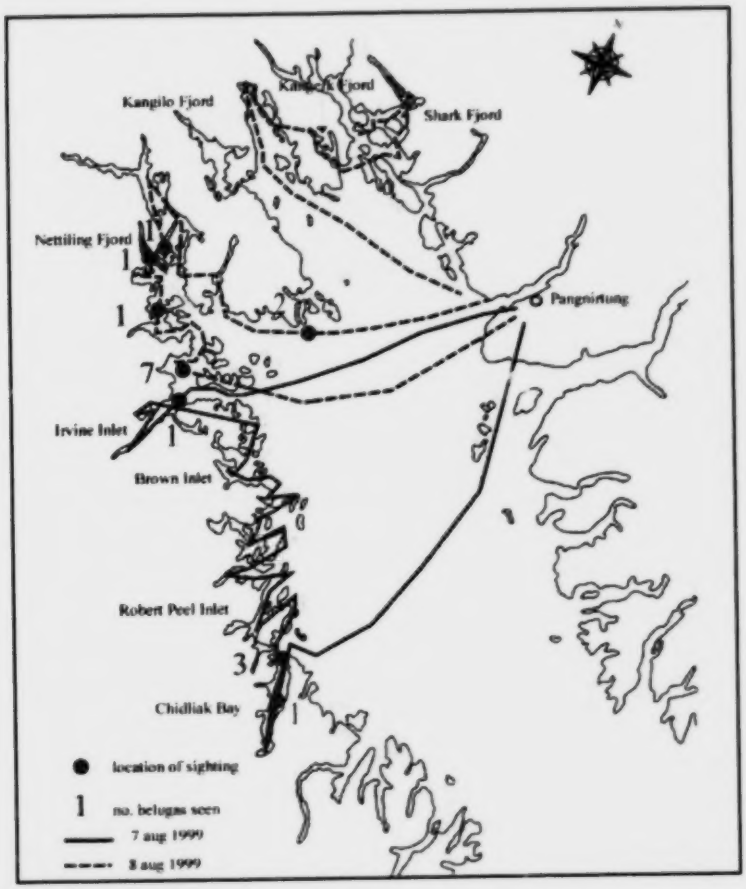

Figure 5. Aerial visual reconnaissance survey of the bays and fiords of western Cumberland Sound in August 1999.

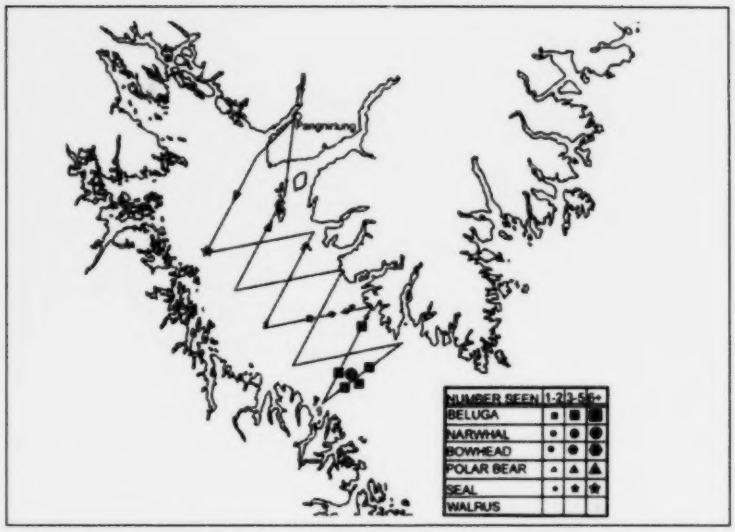

Fig. 6. Sightings of belugas and other marine mammals during aerial visual surveys on 21 March 2000.

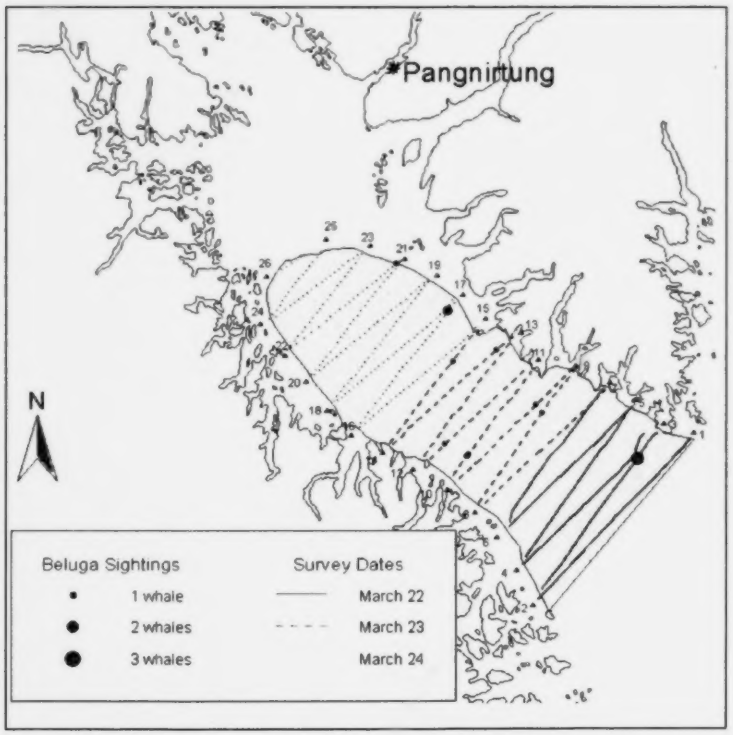

Figure 7. Sightings of belugas during aerial visual surveys on 22-24 March 2003.

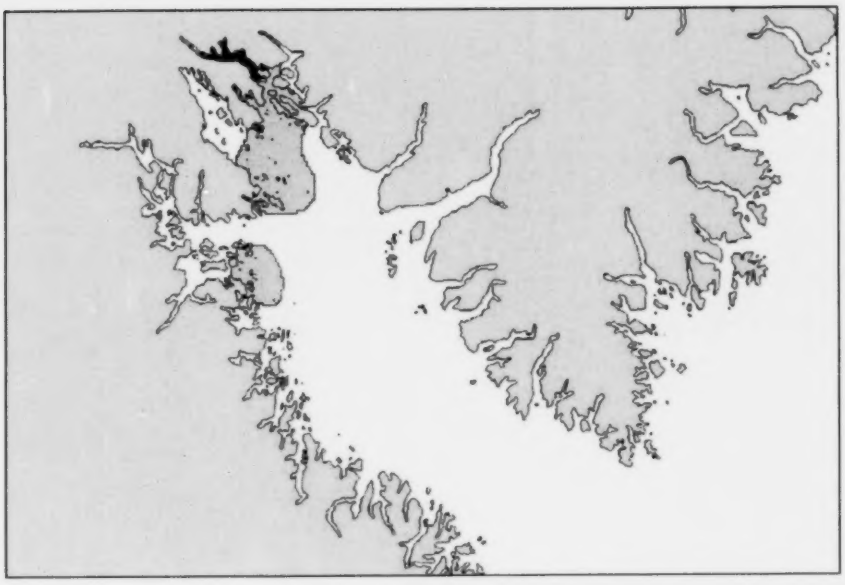

Figure 8. Fixed-kernel range estimates of the July distribution of tagged Cumberland Sound belugas (black: 50 percentile; dark grey 75 percentile; light grey: 95 percentile; red dots: estimated locations).

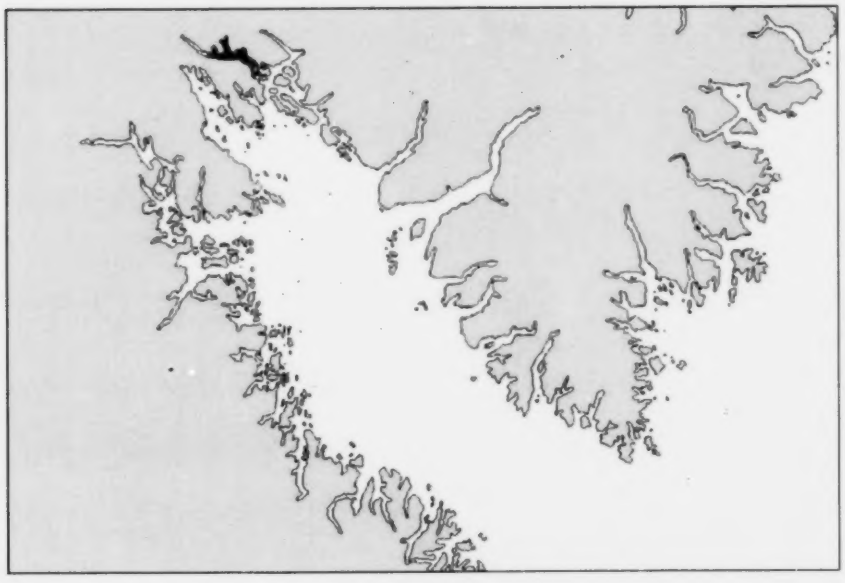

Figure 9. Fixed-kernel range estimates of the August distribution of tagged Cumberland Sound belugas (black: 50 percentile; dark grey 75 percentile; light grey: 95 percentile; red dots: estimated locations).

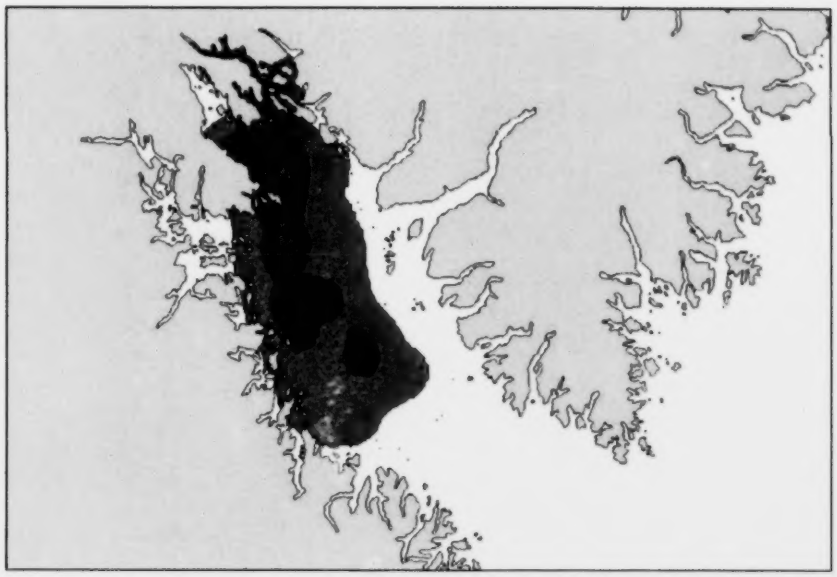

Figure 10. Fixed-kernel range estimates of the September distribution of tagged Cumberland Sound belugas (black: 50 percentile; dark grey 75 percentile; light grey: 95 percentile; red dots: estimated locations).

Figure 11. Fixed-kernel range estimates of the October distribution of tagged Cumberland Sound belugas (black: 50 percentile; dark grey 75 percentile; light grey: 95 percentile; red dots: estimated locations).

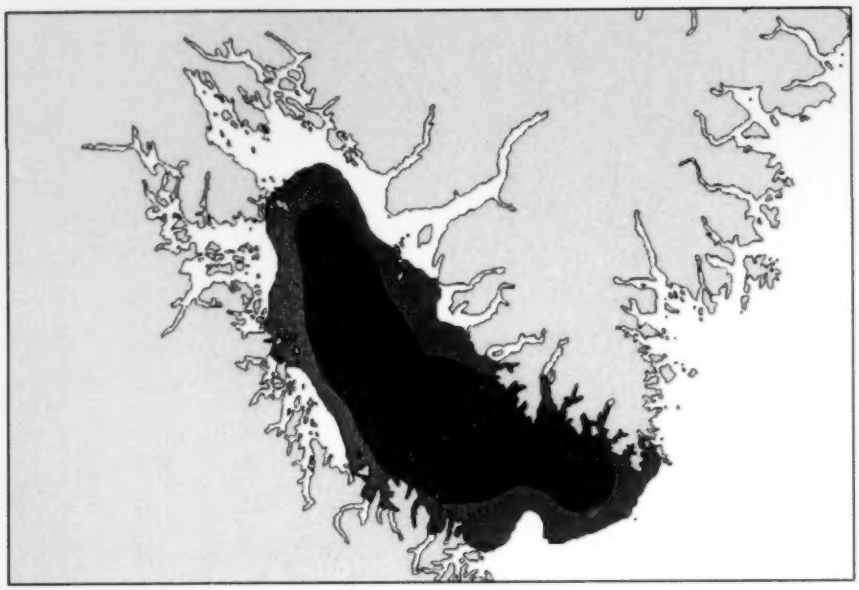

Figure 12. Fixed-kernel range estimates of the November distribution of tagged Cumberland Sound belugas (black: 50 percentile; dark grey 75 percentile; light grey: 95 percentile; red dots: estimated locations).

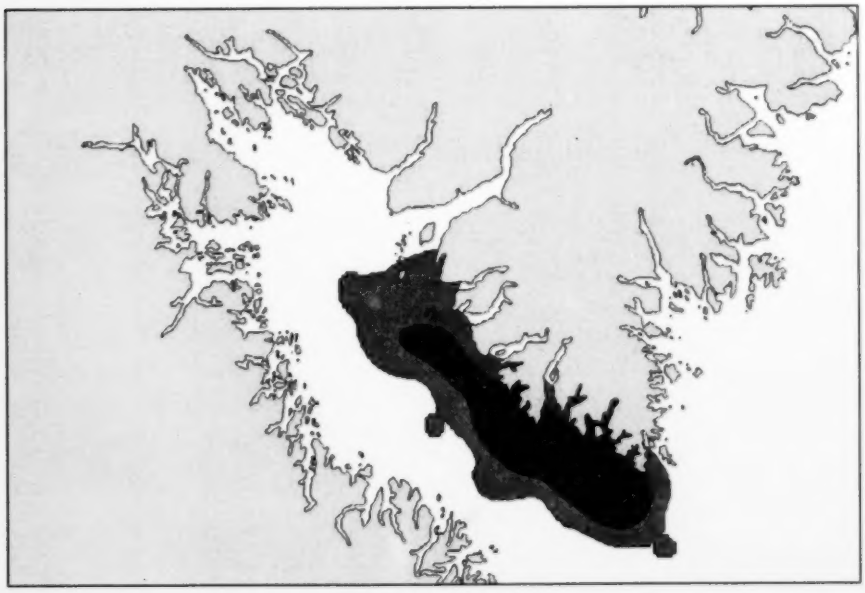

Figure 13. Fixed-kernel range estimates of the December distribution of tagged Cumberland Sound belugas (black: 50 percentile; dark grey 75 percentile; light grey: 95 percentile; red dots: estimated locations).

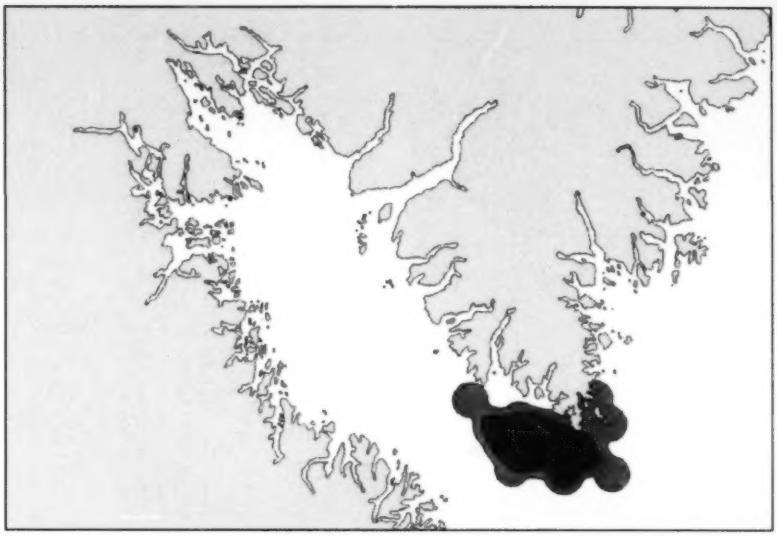

Figure 14. Fixed-kernel range estimates of the January distribution of tagged Cumberland Sound belugas (black: 50 percentile; dark grey 75 percentile; light grey: 95 percentile; red dots: estimated locations). Note: small sample size (Table 1).

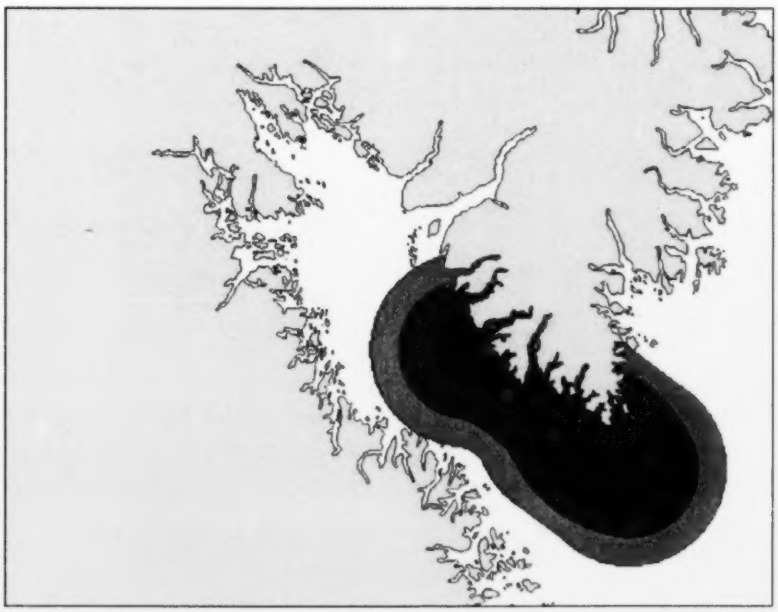

Figure 15. Fixed-kernel range estimates of the February distribution of duty-cycled tagged Cumberland Sound belugas (black: 50 percentile; dark grey 75 percentile; light grey: 95 percentile; red dots: estimated locations). Note: small sample size (Table 1).

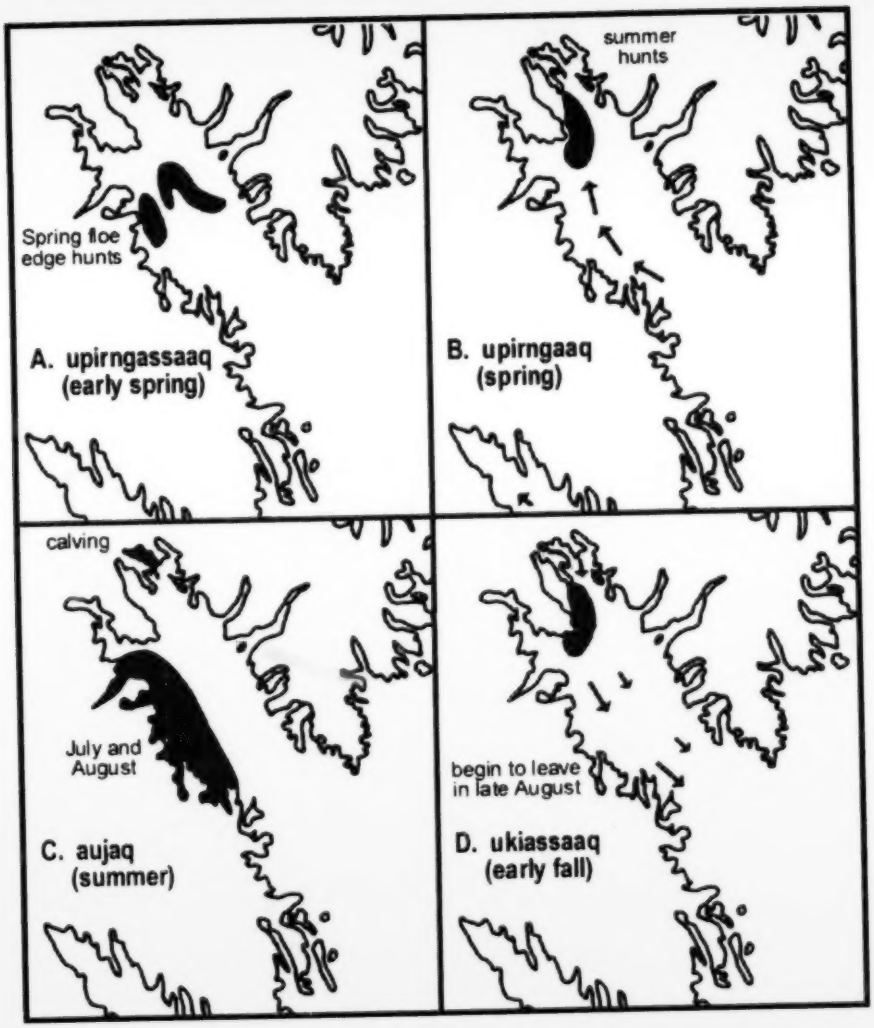

Figure 16. Local knowledge of spring and autumn beluga migration routes in Cumberland Sound (reproduced from Stewart and Savard 2003, adapted from Kilabuk 1998)

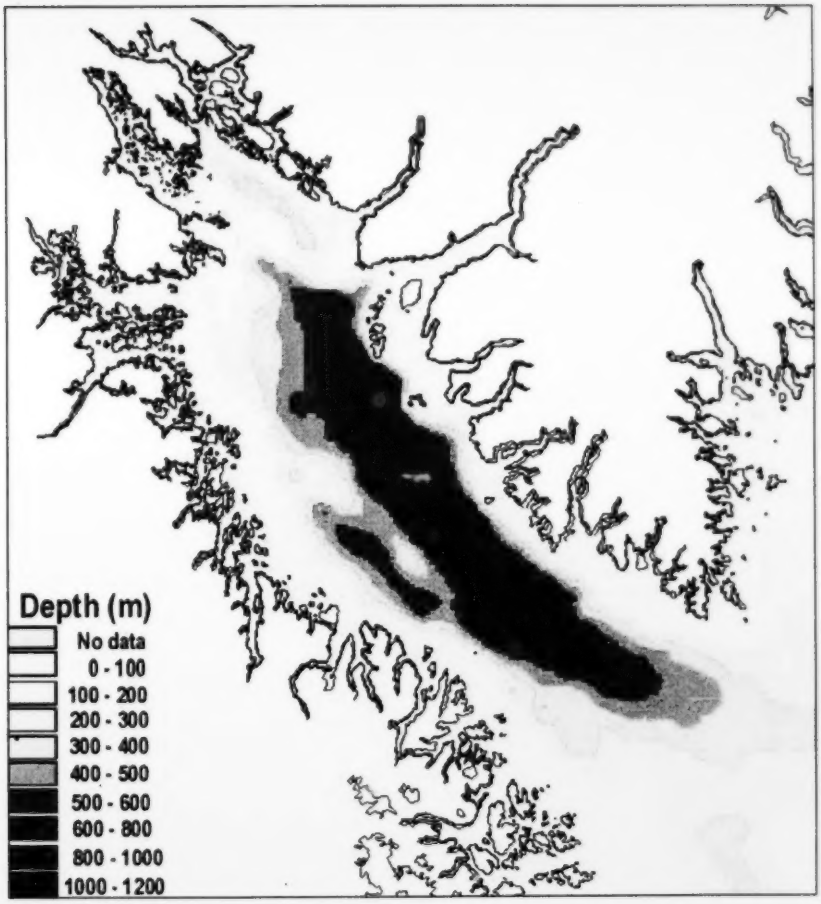

Figure 17. Bathymetry of Cumberland Sound (IBCAO 2002)

Fig. 18. Bathymetric model of Clearwater Fiord (Smith 2005)

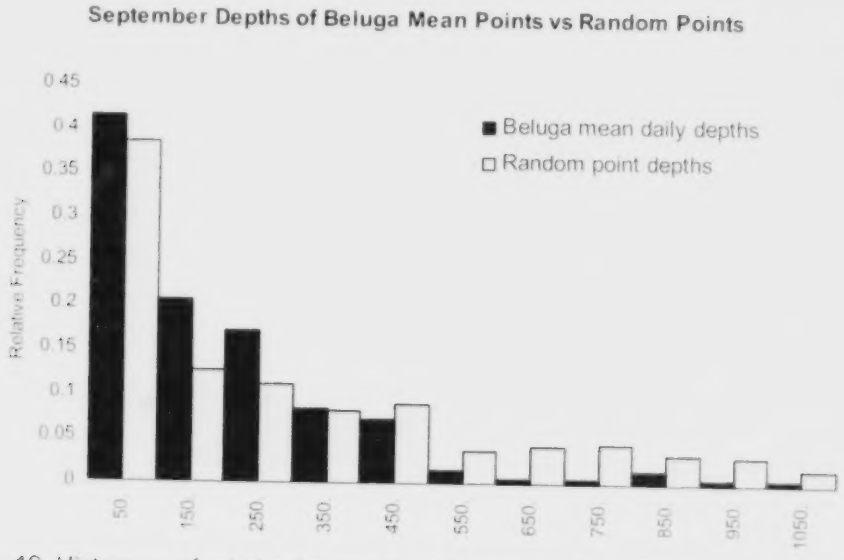

Fig. 19. Histogram of relative frequencies of water depths at September mean daily locations of Cumberland Sound belugas compared to water depth at random locations.

Fig. 18. Bathymetric model of Clearwater Fiord (Smith 2005)

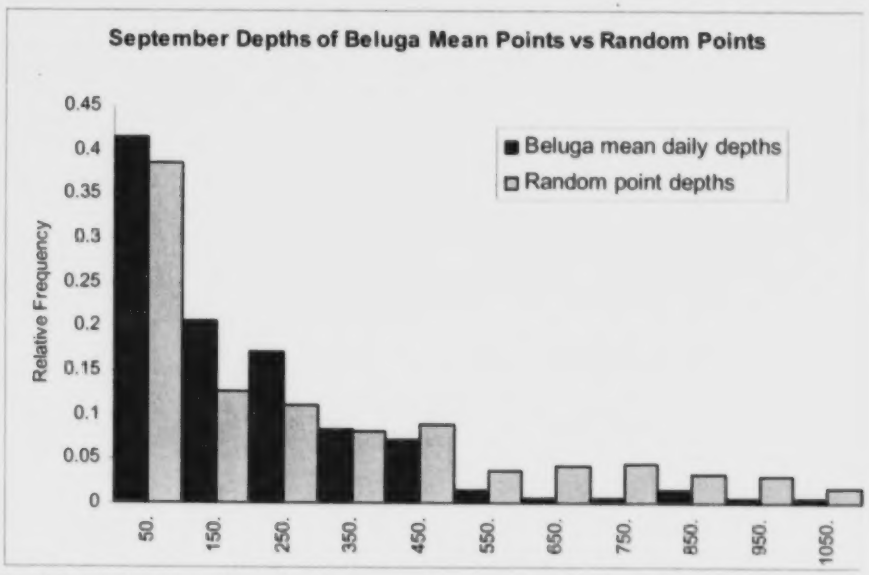

Fig. 19. Histogram of relative frequencies of water depths at September mean daily locations of Cumberland Sound belugas compared to water depth at random locations.

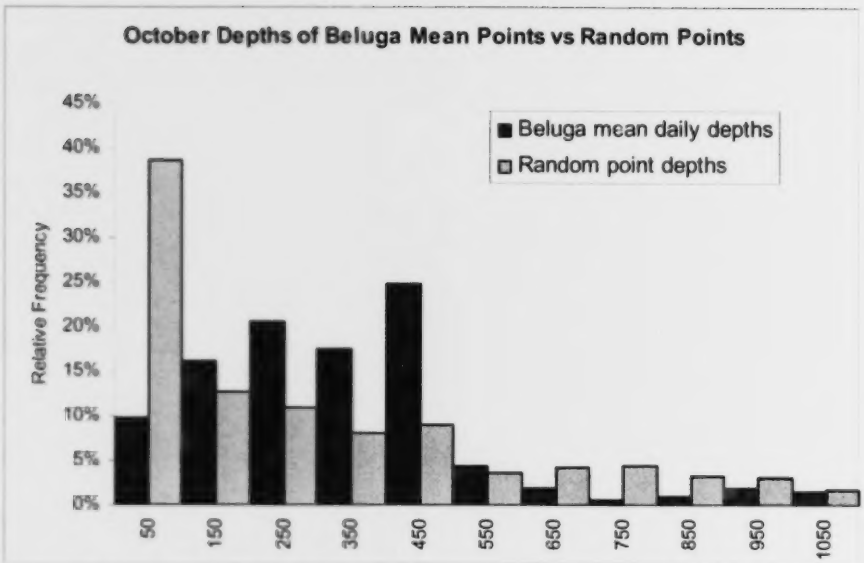

Fig. 20. Histogram of relative frequencies of water depths at October mean daily locations of Cumberland Sound belugas compared to water depth at random locations.

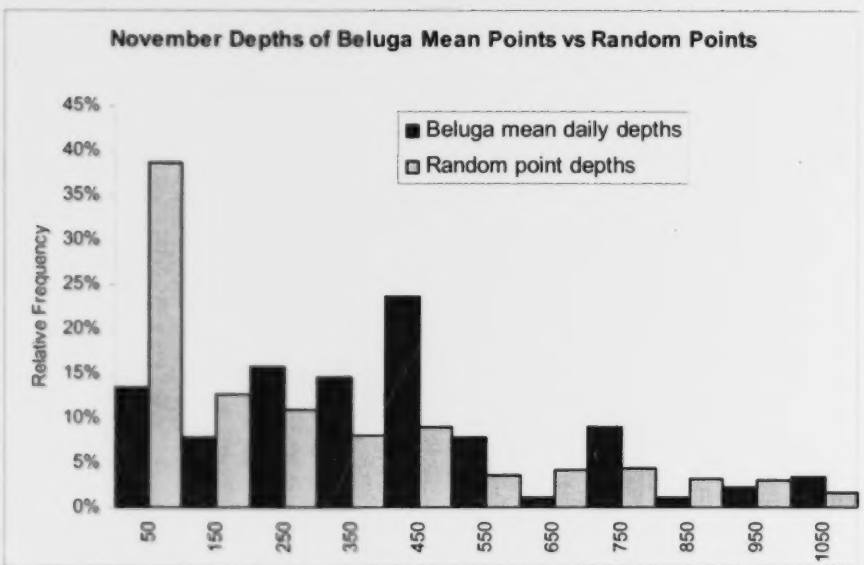

Fig. 21. Histogram of relative frequencies of water depths at November mean daily locations of Cumberland Sound belugas compared to water depth at random locations.

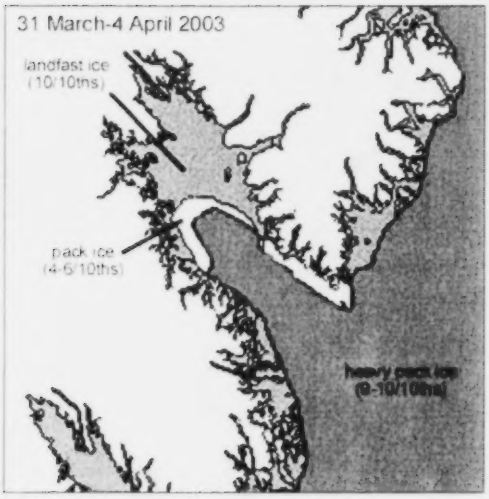

Figure 22. Late-winter distribution of pack ice in Cumberland Sound. Loose pack ice recurs at sites shown in yellow through the winter and from year to year (reproduced from Stewart and Savard 2003)

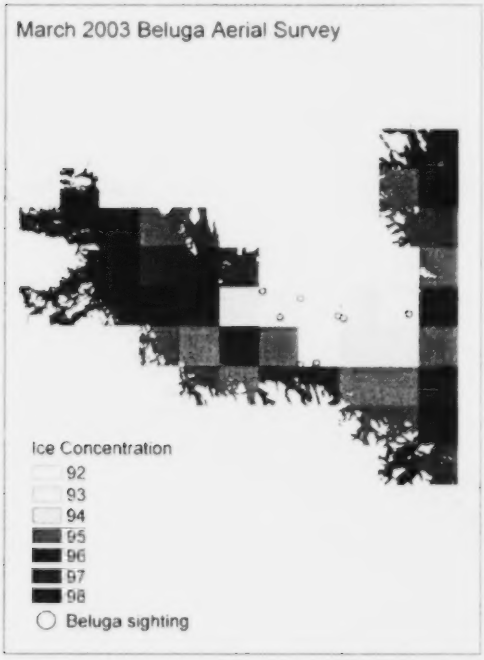

Figure 23. Locations of beluga sightings during 22-24 March 2003 aerial surveys with March week 4 (i.e., 22-30 March 2003) average ice concentration (reproduced from Laidre 2004).

Figure 22. Late-winter distribution of pack ice in Cumberland Sound. Loose pack ice recurs at sites shown in yellow through the winter and from year to year (reproduced from Stewart and Savard 2003)

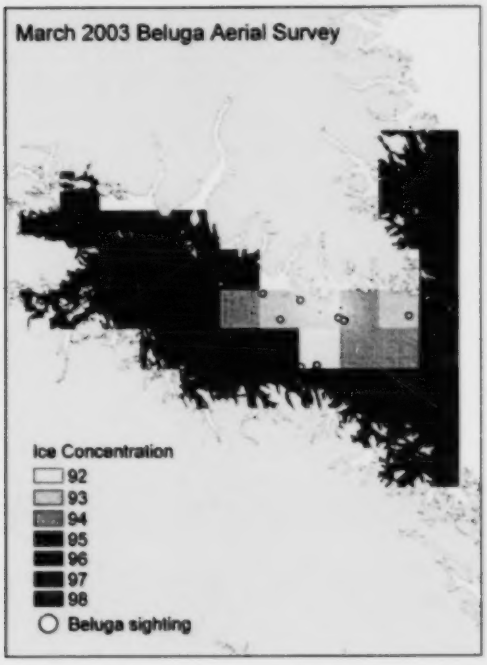

Figure 23. Locations of beluga sightings during 22-24 March 2003 aerial surveys with March week 4 (i.e., 22-30 March 2003) average ice concentration (reproduced from Laidre 2004).